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(54) **SYSTEM AND METHOD FOR MANAGING SECURITY OBJECTS**

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(52) **U.S. Cl.** **707/10**; 707/9; 709/220; 713/200; 713/201; 713/202
(58) **Field of Search** 707/9–10; 713/200–202; 709/220

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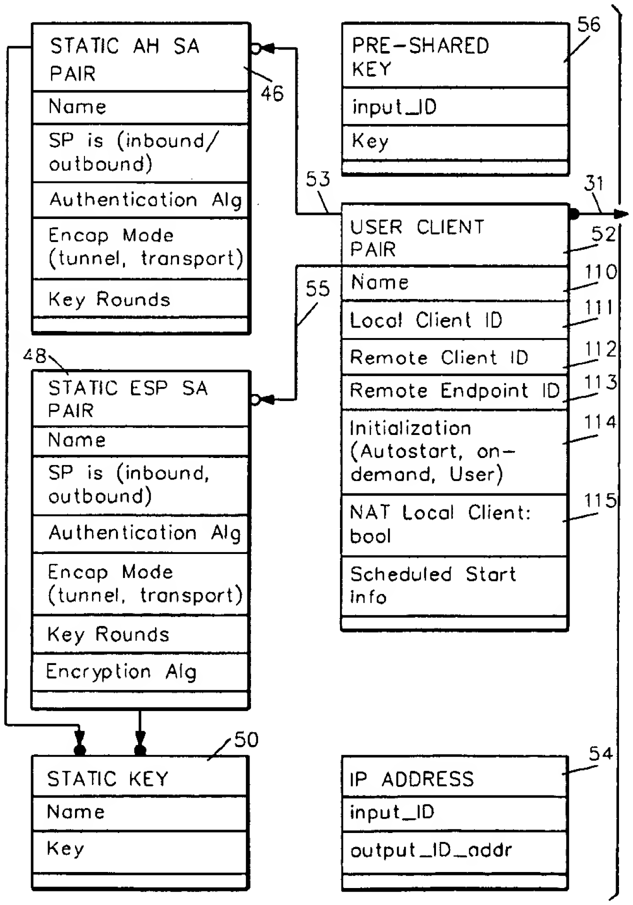
(57) **ABSTRACT**

A data model for abstracting customer-defined VPN security policy information. By employing this model, a VPN node (computer system existing in a Virtual Private Network) can gather policy configuration information for itself through a GUY, or some distributed policy source, store this information in a system-defined database, and use this information to dynamically negotiate, create, delete, and maintain secure connections at the IP level with other VPN nodes.

15 Claims, 6 Drawing Sheets



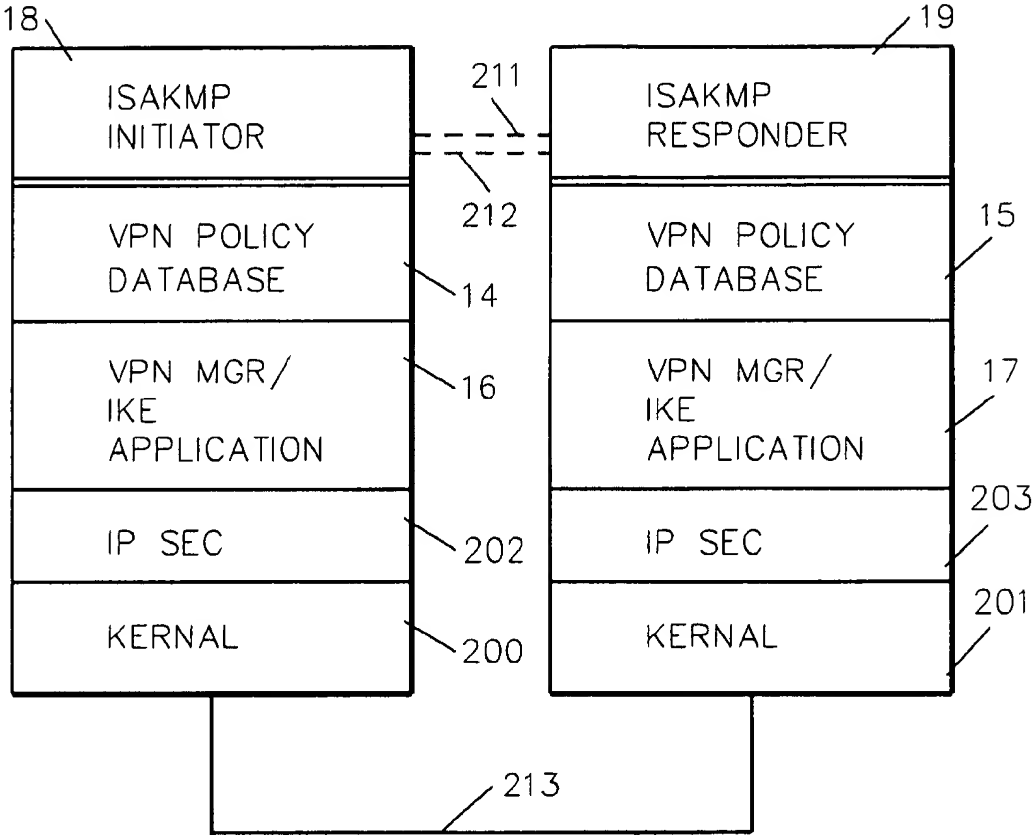

18
ISAKMP
INITIATOR
VPN POLICY
DATABASE
VPN MGR/
IKE
APPLICATION
IP SEC
KERNAL
211
212
14
16
202
200
19
ISAKMP
RESPONDER
VPN POLICY
DATABASE
VPN MGR/
IKE
APPLICATION
IP SEC
KERNAL
15
17
203
201
213

FIG. 1

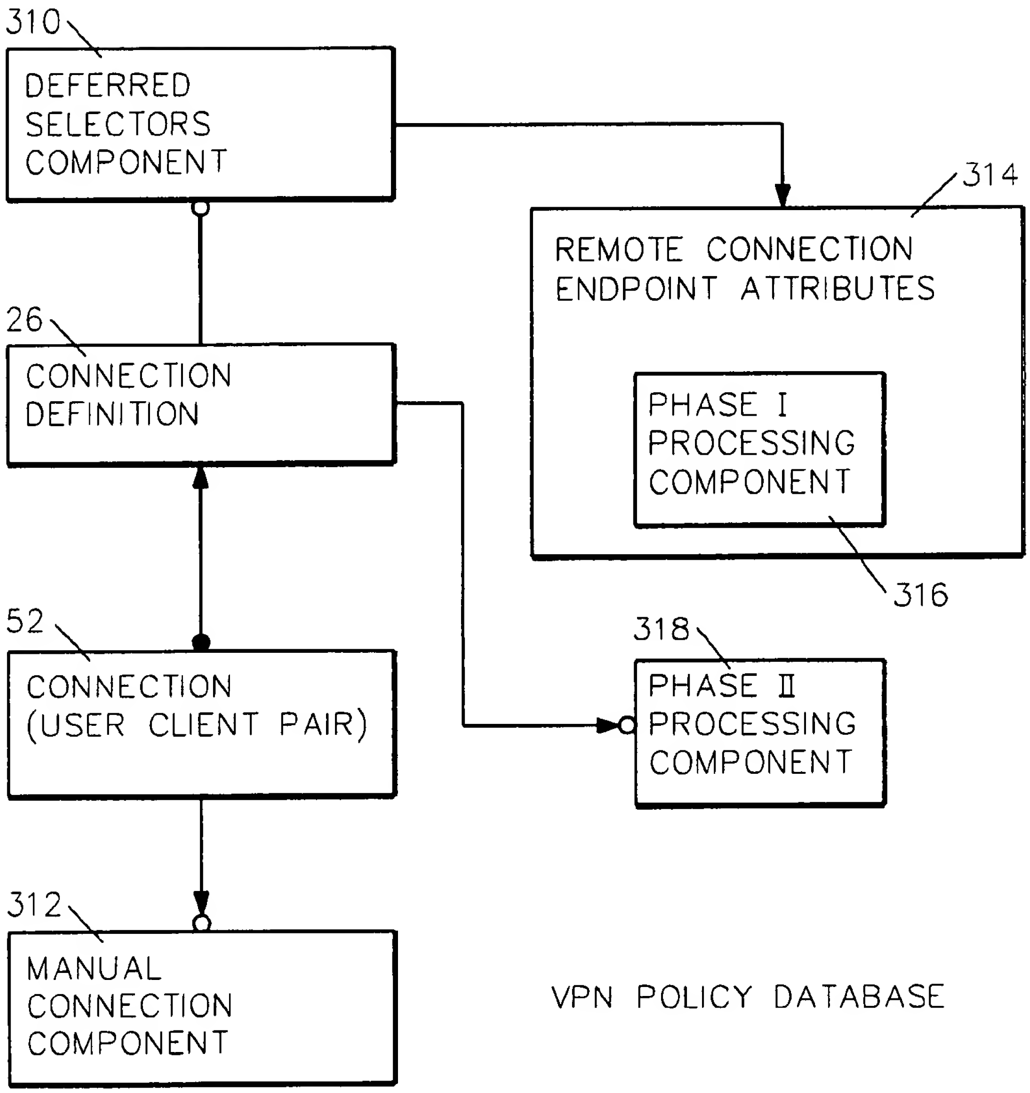

310
DEFERRED SELECTORS COMPONENT
314
REMOTE CONNECTION ENDPOINT ATTRIBUTES
26
CONNECTION DEFINITION
PHASE I PROCESSING COMPONENT
316
52
318
CONNECTION (USER CLIENT PAIR)
PHASE II PROCESSING COMPONENT
312
MANUAL CONNECTION COMPONENT
VPN POLICY DATABASE

FIG. 2

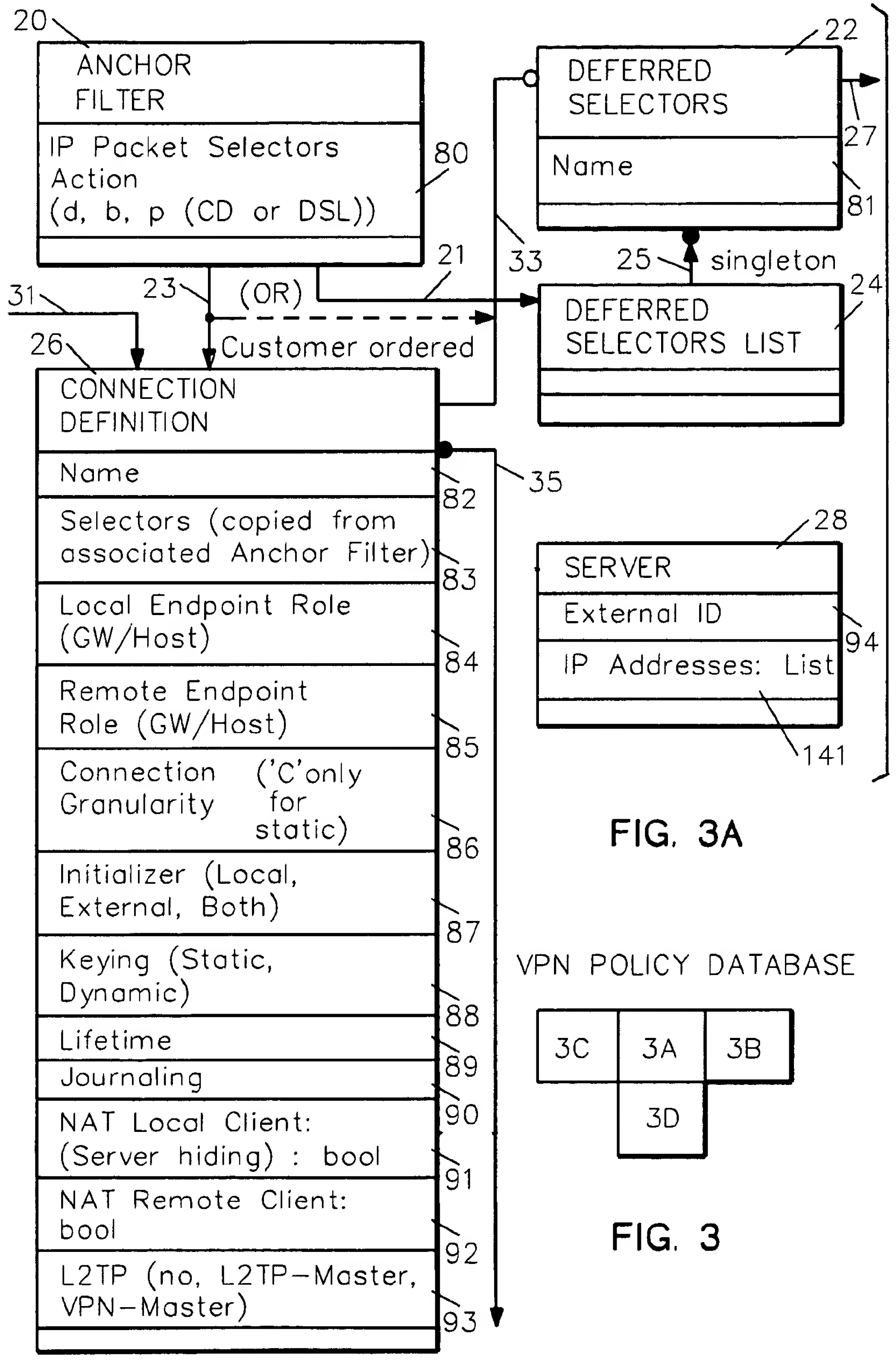


FIG. 3A

VPN POLICY DATABASE

FIG. 3

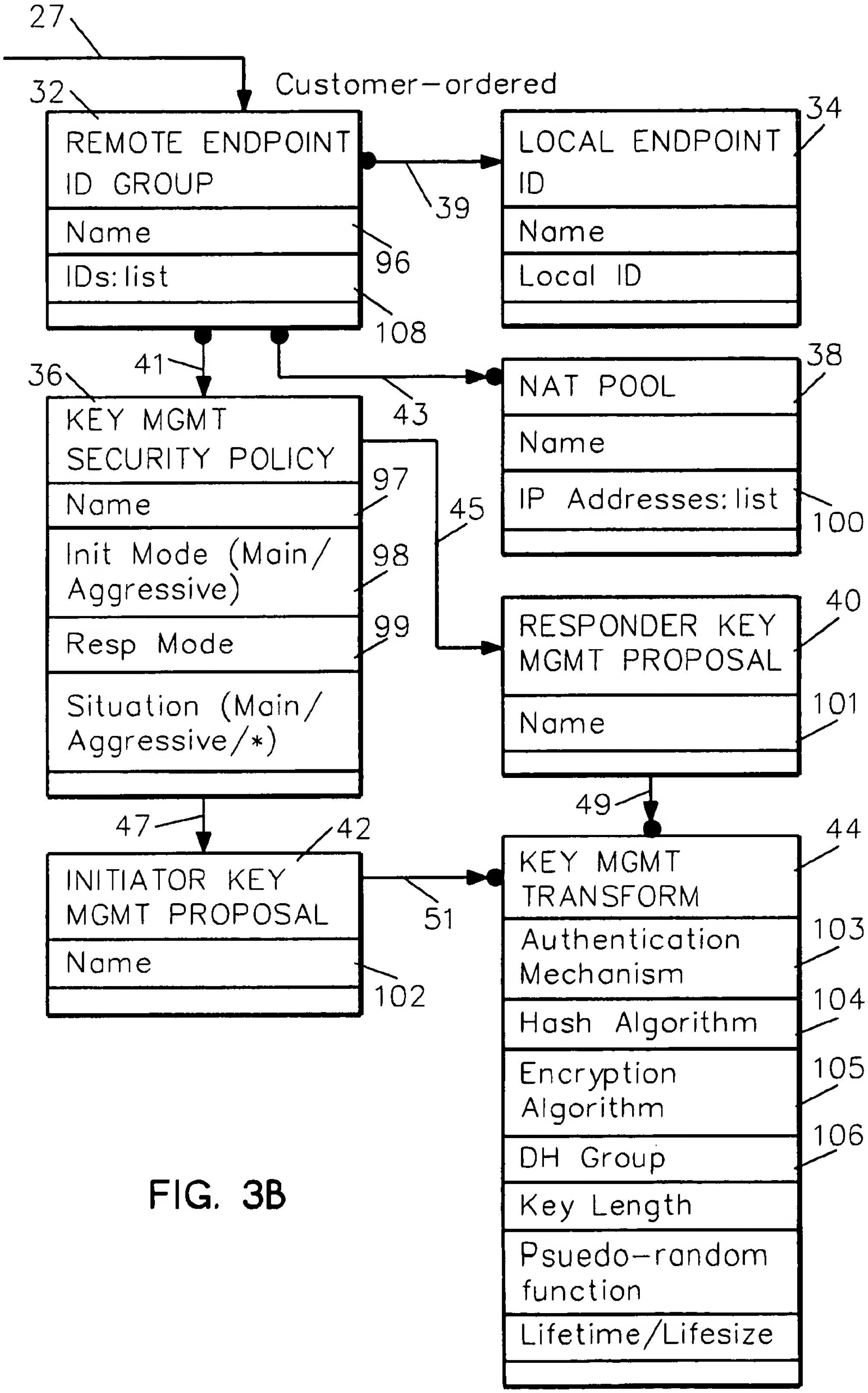

27
Customer-ordered
32
REMOTE ENDPOINT ID GROUP
Name
IDs: list
96
108
39
34
LOCAL ENDPOINT ID
Name
Local ID
41
36
43
38
NAT POOL
Name
IP Addresses: list
100
KEY MGMT SECURITY POLICY
Name
Init Mode (Main/ Aggressive)
Resp Mode
Situation (Main/ Aggressive/*)
97
98
99
45
40
RESPONDER KEY MGMT PROPOSAL
Name
101
49
47
42
44
INITIATOR KEY MGMT PROPOSAL
Name
102
51
KEY MGMT TRANSFORM
Authentication Mechanism
Hash Algorithm
Encryption Algorithm
DH Group
Key Length
Psuedo-random function
Lifetime/Lifesize
103
104
105
106

FIG. 3B

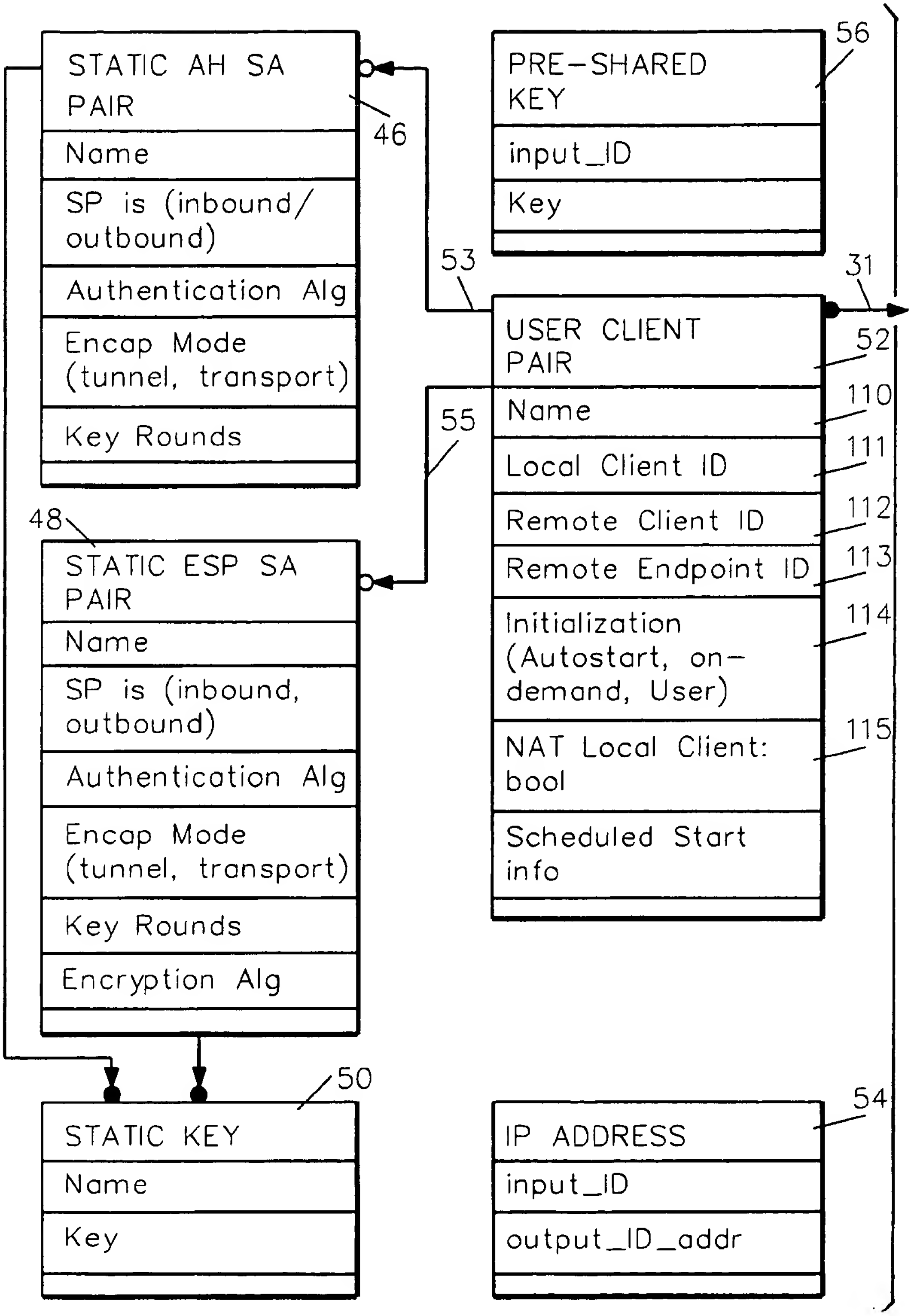

STATIC AH SA PAIR
Name
SP is (inbound/ outbound)
Authentication Alg
Encap Mode (tunnel, transport)
Key Rounds
46
PRE-SHARED KEY
input_ID
Key
56
53
31
USER CLIENT PAIR
52
Name
110
Local Client ID
111
Remote Client ID
112
Remote Endpoint ID
113
Initialization (Autostart, on-demand, User)
114
NAT Local Client: bool
115
Scheduled Start info
55
48
STATIC ESP SA PAIR
Name
SP is (inbound, outbound)
Authentication Alg
Encap Mode (tunnel, transport)
Key Rounds
Encryption Alg
50
STATIC KEY
Name
Key
54
IP ADDRESS
input_ID
output_ID_addr

FIG. 3C

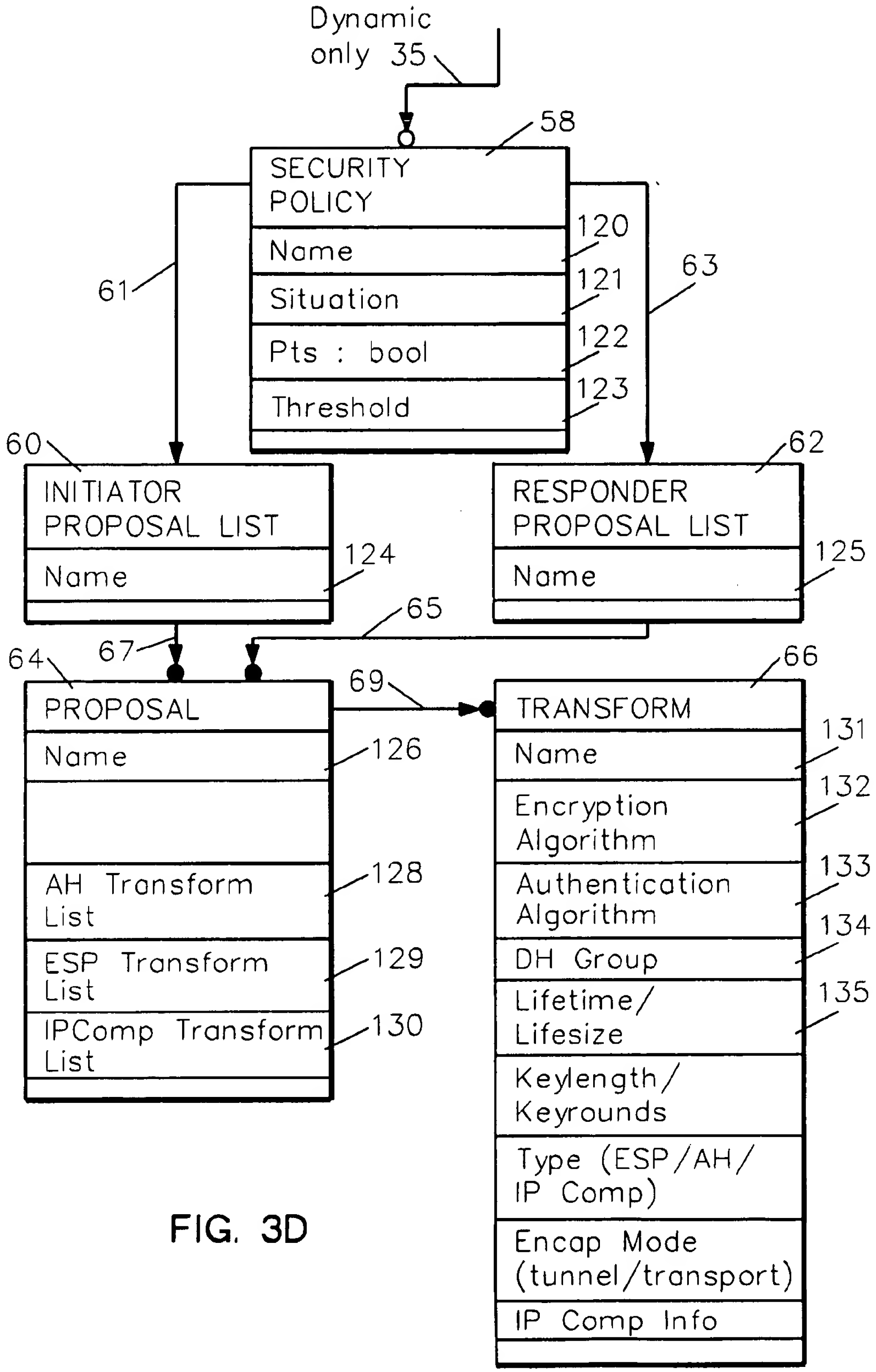

Dynamic
only 35
58
SECURITY
POLICY
Name
Situation
Pts : bool
Threshold
120
121
122
123
61
63
60
INITIATOR
PROPOSAL LIST
Name
124
62
RESPONDER
PROPOSAL LIST
Name
125
65
64
67
PROPOSAL
Name
AH Transform
List
ESP Transform
List
IPComp Transform
List
126
128
129
130
69
66
TRANSFORM
Name
Encryption
Algorithm
Authentication
Algorithm
DH Group
Lifetime/
Lifesize
Keylength/
Keyrounds
Type (ESP/AH/
IP Comp)
Encap Mode
(tunnel/transport)
IP Comp Info
131
132
133
134
135

FIG. 3D

SYSTEM AND METHOD FOR MANAGING SECURITY OBJECTS

CROSS REFERENCES TO RELATED APPLICATIONS

U.S. patent application Ser. No. 09/240,720, entitled "System and Method for Network Address Translation Integration With IP Security"; Ser. No. 09/239,694, entitled "System and Method for Dynamic Micro Placement of IP Connection Filters"; Ser. No. 09/240,483, entitled "System and Method for Central Management of Connections in a Virtual Private Network; and Ser. No. 09/240,718, entitled "System and Method for Dynamic Macro Placement of IP Connection Filters", filed concurrently herewith are assigned to the same assignee hereof and contain subject matter related, in certain respects, to the subject matter of the present application. The above-identified patent applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

This invention pertains to data security. More particularly, it pertains to the creation, deletion and retrieval of security connection objects and the querying of cryptographic services.

2. Background Art

It is currently state of the art of the Internet to create Virtual Private Networks (VPNs) using Internet Protocol Security (IPSec). However, there exists no standard nor current implementation for configuring and implementing the connection of systems in this Internet environment, such as between systems using the Transmission Control Protocol/Internet Protocol (TCPIP) and systems using the Internet Protocol Security (IPSec). Typically, graphical user interfaces (GUIs) are provided that configure data security policies only. There is, therefore, a need in the art to provide a connection model and GUI for configuring the connection of disparate systems, particularly in an Internet environment.

With the onset of network computing came the need to insure secure connections between networked computers. Usually companies resorted to establishing private networks to do this, and at considerable expense. However, as this trend of Network Computing continues to evolve, it is necessary to extend secure communications within the enterprise and to utilize the public networks. Driving factors include the need for mobility, company mergers and acquisitions, and the usual 'improving the bottom line'. Virtual Private Networks (VPNs), in this context, allow customers to use existing private or public networks, including the Internet, to establish secure connections between other businesses, branch offices, and remote users. One problem with VPNs is they are usually implemented via proprietary techniques, such that interoperability is limited to single vendor solutions. The IETF now has working groups and draft standards which will allow a more uniform VPN solution across vendors that implement to those standards. IP Security (IPSEc) and Internet Security Association Key Management Protocol (ISAKMP) are examples of these standards and these are the standards used in the preferred embodiment of the invention.

Current systems apply static, predefined filter rules (SPD entries, in RFC2401 terms) to a system interface. When attempting to negotiate with a remote system, if the client identifiers IDci and IDcr from the remote system do not match exactly an existing filter rule, the negotiation is unsuccessful. IDci and IDcr are the identifiers for clients of Security Associations (SAs), where ci refers to client initiator and cr to client responder. An SA is an ISAKMP (sometimes referred to as the Internet Key Exchange (IKE), which defines the IPSec domain of interpretation of the ISAKMP framework) unidirectional security protocol specific set of parameters that defines the services and mechanism necessary to protect traffic between two nodes. Consequently, there is a need in the art for enabling acceptance of previously unknown IDci and IDcr values from a remote system. Further, current implementations may have a filter rule for all IP traffic between a local host and a given subnet through a remote gateway. If so, the only connection allowed is for this set of IP traffic, and if the remote host does not have a corresponding filter rule, no connection can be established. There is, therefore, a need in the art for dynamically generating, loading and managing multiple IPSec filter rules (SPD entries) for traffic between a local host and a given subnet through a remote gateway.

Current system provide ISAKMP phase I and phase II connections. A phase I connection is an ISAKMP-to-ISAKMP secure connection used to negotiate keying material for phase II connections. A phase II connection is the actual IPSec connection to secure IP datagrams. Usually, a phase I connection is managed in a similar manner to a phase II connection, in that it is initiated, refreshed, and possibly scheduled independently. There is a need, therefore, in the art for enabling ISAKMP phase II driven phase I connections, such that unnecessary IKE traffic is avoided by only creating or refreshing a phase I connection if there is an active phase II connection that currently requires it.

Currently, filter rules are written statically with predefined IP selectors (IP addresses, port numbers, and transport protocol). However, when dealing with a dynamically assigned IP address from a third party (such as an Internet Service Provider, or ISP), there is no way currently of knowing what IP address to configure in the rules, particularly for handling different security policies for different hosts (users). There is, therefore, a need in the art for enabling connection filter rules to be generated and loaded dynamically at negotiation time, and thus handle remote initiating hosts with dynamically assigned IP addresses.

It is a further object of the invention to provide a system and method for creating, maintaining, deleting and retrieving VPN policy objects.

It is a further object of the invention to provide a system and method for enabling acceptance of previously unknown IDci/IDcr values from a remote system.

It is a further object of the invention to provide a system and method enabling dynamic generation, load, and management of multiple IPSec filter rules.

It is a further object of the invention to provide a system and method enabling ISAKMP phase II driven phase I connections.

It is a further object of the invention to provide a system and method enabling handling of remote initiating hosts with dynamically assigned IP addresses, that may have differing security policy requirements.

It is a further object of the invention to provide a system and method providing flexibility in policy definition in the areas of dynamically-assigned IP addresses, remotely-defined ISAKMP client IDs (IDci/IDcr), and separation of ISAKMP Phase I (key management) policy information from ISAKMP Phase II (data management) policy information.

It is a further object of the invention to provide a data model for representing and abstracting IPSec/ISAKMP-based VPN configuration information for an IPSec-capable computer system in a virtual private network that (1) allows for each customer-generated customer-ordered security policy database (SPD) entry, multiple VPN connections to be dynamically established (these connections may or may not have been previously defined); (2) allows for a data-security-policy-driven approach to rekeying (via ISAKMP) where (a) the key management connection (i.e. the secure connection used to exchange keying material for the data connections) is created and maintained by security policy and on an on-demand basis by data connection activity, and (b) the key connection security policy is determined solely by the identity of the remote connection endpoint; (3) allows for dynamically establishing VPN connections with different security policies and other attributes, based solely on an unfixed IP address (e.g. a user ID)—these connections may or may not have been previously defined. This aspect is used for supporting systems with dynamically-assigned IP addresses that wish to establish a VPN connection with the local system.

SUMMARY OF THE INVENTION

In accordance with the invention, a data model is provided for abstracting customer-defined VPN security polity information. By employing this model, a VPN node (computer system existing in a Virtual Private Network) can gather policy configuration information for itself through a GUI, or some distributed policy source, store this information in a system-defined database, and use this information to dynamically negotiate, create, delete, and maintain secure connections at the IP level with other VPN nodes.

Other features and advantages of this invention will become apparent from the following detailed description of the presently preferred embodiment of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a high level system diagram illustrating initiator and responder nodes.

FIG. **2** is a high level system diagram illustrating the VPN policy database of FIG. **1**, in accordance with the preferred embodiment of the invention.

FIGS. **3A** through **3D**, arranged as illustrated in FIG. **3**, are an object notation representation of the preferred embodiment of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

In accordance with the invention, a data model is provided for abstracting customer-defined VPN security polity information. By employing this model, a VPN node (computer system existing in a Virtual Private Network) can gather policy configuration information for itself through a GUI, or some distributed policy source, store this information in a system-defined database, and use this information to dynamically negotiate, create, delete, and maintain secure connections at the IP level with other VPN nodes.

Referring to FIG. **1**, a Virtual Private Network Connection Model (VPNCM) **14, 15** exists as a database, or other persistent storage medium, on each node **18, 19** in the VPN and executes under control of IKE (an ISAKMP application) and/or some other connection manager application **16, 17** and IPSec **202, 203** on each of initiator node **18** and responder node **19**, respectively. These nodes **18, 19** may be host or gateway nodes, or systems, and are referred to as connection endpoints. Once a connection is created, filter rules (or SPD entries) and Security Associations (SAs) are loaded into the IP stack in the kernal **200, 201** to protect the connection's traffic as it passes through the stack. In a preferred embodiment of the invention, the VPN Conn Model is implemented as a database and is used by VPN Conn Mgr. IKE may be optional, since manual connections may be the only type configured. Initiator and responder are ISAKMP terms. Line **211** represents ISAKMP Phase I negotiations and line **212** represents ISAKMP Phase II negotiations. Phase II is an ISAKMP term for the negotiation of keys to protect the actual user data (i.e. the real VPN connection). This is in contrast to Phase I, which is the negotiation of keys for a ISAKMP/ISAKMP **18/19** connection to protect Phase II negotiations. Line **213** represents the resulting VPN connection protected by an IPSec.

The preferred embodiment of the invention calls for IP Security (IPSec) **202, 203** protocols (IETF RFC 2401 et al.) as the means of data protection and, optionally, Internet Security Association Key Management Protocol (ISAKMP) (IETF RFC 2408 et al.) for the means of maintaining the keys used by the negotiated IPSec protocols.

In accordance with the preferred embodiment of the invention, a connection model is provided for describing a connection policy between systems, such as between systems using the Transmission Control Protocol/Internet Protocol (TCPIP) and Internet Protocol Security (IPSec) to protect their datagrams. This preferred embodiment has been designated the Virtual Private Network Connection Model (VPNCM), and provides a way to represent connections in a Virtual Private Network (VPN). The model abstracts common information about these connections, and allows multiple connections to be based on a single connection definition. Furthermore, these connection definitions reference data security policies that describe how the traffic in a connection is protected. This enables multiple connection definitions to reference relatively few security policies. Systems participating in VPNs may have IP addresses dynamically assigned. The preferred embodiment of the invention (VPNCM) accounts for connecting to a remote system that has a dynamically-assigned IP address by using deferred selectors.

While it is currently within the state of the art to create Virtual Private Networks using Internet Protocol Security (IPSec), the Request For Comments (RFCs) and Internet Drafts for IPSec are only concerned with the lower layer of IP architecture, key exchanges, cryptographic algorithms and such. There is not standard for configuration and implementation of the connection of systems.

Referring to FIG. **2**, VPN policy database **14, 15** is illustrated, with an instance at each of initiator node **18** and responder node **19**. Each VPN policy data base **14, 15** includes deferred selectors component **310**, connection definition **26**, connection **52**, manual connection component **312**, remote connection endpoint attributes component **314** including phase 1 processing component **316**, and phase 2 processing component **318**. Each of these VPN policy data base **14, 15** objects will be further described in connection with FIG. **3**.

User client pair **52** has a 1:1 correspondence to a connection (element **140**, FIG. **9** of copending application Ser. No. 09/240,483), and represents and defines the attributes of a connection which can be instantiated (or started). When started, connection **52** gets from connection definition **26** information configured by a user by way of an anchor filter. Connection definition **26** defines how datagrams which match the anchor filter are to be protected. See copending patent application Ser. No. 09/240,718 and 09/239,694 for a description of anchor filters and their use with connection filters. User Client Pair **52** defines connection properties and, with connection definition **26** provides the information required to instantiate a connection. In so doing, if keying is static, then manual connection component **312** is accessed for additional information and if keying is dynamic, additional information is accessed from phase II processing component **318**. For both static and dynamic keying, user client pair **52** contains a pointer to remote connection endpoint attributes component **314** to find the local endpoint ID and related attributes, including those of phase I processing component **316**.

In the case where this local system **19** is responding to initiator system **18**, initiator **18** will provide a client ID pair specifying the set of IP traffic that the connection being proposed will protect. Responder system **19** accesses its VPN policy database **15** and checks the connection definitions **26** therein to determine if the client ID pair provided by initiator **18** defines a proposed set of IP traffic (datagrams) which is a subset of the IP traffic associated with a connection definition **26** and which, therefore, responder system **19** is configured to protect.

User Client Pairs **52** map 1:1 to connections that are defined to be initiated locally. When initiating a dynamic connection, the keying attribute in connection definition **26** of the VPN policy database **14** at initiator node **18** will indicate dynamic. Consequently, initiator **18** will negotiate with responder **19**, defined by the remote endpoint ID **113** of the user client pair **52** for the connection being started. Responder node **19** will obtain local client ID and remote client ID attributes from initiator **18** as part of ISAKMP Phase II negotiation, and use those IDs to select the connection definition **26** from responder database **15** that defines the connection for the responder side.

Manual connection component **12** provides information for manual (i.e., static) security associations (SAs), which information describes such attributes as encryption and authentication procedures, and must be hand coded by the user, with mirror images on both initiator **18** and responder **19** in order for a manual tunnel to work over connection **213**.

Phase II negotiations **212** occur across a phase I connection **211** and result in a VPN connection **213** which is protected by an IPSec.

In order to enable acceptance at responder node **19** of a previously unknown client ID pair (IDci/IDcr) from initiator node **18**, a connection definition **26** is provided in database **15** for determining if the client ID pair is acceptable to responder **19**, and if so, an ISAKMP phase II negotiation component **318** provides a policy for negotiating this client ID pair.

In order to enable dynamic generation, loading and management of multiple IPSec filter rules (i.e., connection filters), a connection definition **26** is provided at responder node **19** for selection by either a user client pair **52** or a client ID pair (IDci/IDcr) received from a remote initiator for identifying pertinent granularity attributes. These granularity attributes define the subset of IP datagrams that can be associated with any one connection instantiated from this connection definition **26**.

In order to enable ISAKMP phase II driven phase I connections, whereby a phase I connection is only created or refreshed based upon phase II connection activity, a reference pointer (represented by line **41**, FIG. **3B**) is provided for associating a remote endpoint identifier in remote connection attributes **314** with a phase I negotiation policy in phase I processing component **316**.

In order to enable handling at responder node **19** of remote initiating hosts **18** with dynamically assigned IP addresses, there is provided at responder node **19** policy database **15** connection definitions **26** for identifying ISAKMP phase II negotiation policies in phase II processing component **318**, anchor filters **20** (FIG. **3A**) for defining the datagrams that may be associated with a remote host **18** using dynamically assigned IP addresses, and deferred selectors component **310** providing a one to many mapping from an anchor filter **20** to connection definitions **26**.

In accordance with the preferred embodiment of the invention, previously unknown client ID pairs (IDci and IDcr values) are accepted from a remote system. The user writes as few as one filter rule (also referred to as an anchor rule) for the subset of IP traffic to be protected, similar to conventional filter rules. However, this anchor filter rule, by way of its association with a connection definition, is not explicit about what future security associations (SAs) will be used to protect any of the traffic defined by the anchor rule. It only specifies things like what policy to negotiate and what granularity of client IDs to accept. Connection filters are generated and loaded dynamically based on either locally defined connections (user client pair objects **52**), IDci/IDcr from a remote system, or from an IP packet (for on demand connections). If a remote system offers client IDs of, say, only TCP traffic between the local host and a given subnet, connection filters for that traffic only would be generated and loaded, with all other traffic between the local host and the given subnet discarded.

Further in accordance with the preferred embodiment of the invention, ISAKMP phase II driven phase I connections are enabled. That is, a phase I connection is only created or refreshed if there is an active phase II connection that requires it. This reduces unnecessary IKE traffic. Also, phase I security policy and other attributes are based solely on the remote endpoint and not on the phase II traffic being ultimately protected, thus easing setup and policy definition.

Further, in accordance with the preferred embodiment of the invention, remote initiating hosts with dynamically assigned IP addresses are handled through the use of deferred selectors. With as little as one anchor filter, connection filter rules can be generated and loaded dynamically at negotiation time. Negotiation is performed using a non-IP-type selector, such as user@FQDN, for both phase I and phase II (whereas phase II negotiations are usually performed using IP-type only client IDs). Following successful negotiation and authentication via IKE, the remote host IP address for the filter rules is determined by the IP packet source address.

Referring to FIG. **3**, the preferred embodiment of the data model of FIG. **2**, designated VPNCM, is set forth in object notation. In the embodiment of FIG. **3**, deferred selectors component **310** of FIG. **2** is implemented by deferred selectors **22** and deferred selectors list **24**; manual connection component **312** is implemented by static ESP SA pair **48**, static AH SA pair **46** and static key **50**; remote connection endpoint attributes **314** is implemented by remote endpoint ID group **32**, local endpoint ID **34**, NAT pool **38**, and IP address **54**, and also including in phase I processing component **316**, key management security policy **36**, initiator key management proposal **42**, responder key management proposal **40**, key management transform **44** and preshared key **56**; and phase II processing component **318** is implemented by security policy **58**, initiator proposal list **60**, responder proposal list **62**, proposal **64** and transform **66**.

The notation used on the data model is the Object Model Technique (OMT) notation, and can be found in "Object-Oriented Modeling and Design", by Rumbaugh et al. In accordance with OMT notation, the boxes represent data objects, showing their type (e.g. Connection Definition) and the attributes associated with this type of object. The lines represent association, specifically references. An arrowed line is a one-way reference. A line with no arrows implies a two-way reference. References are usually handled by keeping the name of the referenced object in the data of the referencer. For example, a Security Policy object has a reference to one Initiator Proposal List object and a reference to one Responder Proposal List object, but neither of the Proposal List objects 'know' who holds references to them (hence the arrowheads). The dots (or lack of) show multiplicity. No dot implies one and only one reference. An open dot implies either no reference or at most one reference. The black dot means any number of references (i.e. 0 or more). A black dot with numbers means only those number of references are allowed (e.g. 1+means one or more; 2,4 means either 2 or 4). For example, a connection definition may or may not have a reference to a security policy (depending on the keying attribute being dynamic), but if it does it only has one reference (hence the open dot). On the other hand, any number of connection definitions may reference a particular security policy (hence the black dot).

Anchor filters **20** are provided to indicate to the system that certain IP traffic is to be protected using IPSec. These filters **20** reference a connection definition (CD) **26** that describes the role of the endpoints (host or gateway), and other connection information. There are two ways to establish a connection between systems: initiate the negotiation of a connection, or respond to the negotiation of a connection. In the case of connections with static keys (i.e. Connections that do not manage keys via IKE), both connection endpoints are said to initiate the negotiation of the connection, even though no actual negotiation takes place. Initiators of connections between systems using this connection definition (CD) **26** require a User Client Pair (UCP) **52** for each connection that it can initiate. There may be a multiplicity of UCPs **52** referring to a single CD **26**. CDs **26** also have a reference to the Security Policy (SP) **58** necessary for this connection. There may be a multiplicity of CDs **26** referring to a SP **58**. For systems that derive their IP address dynamically, which is usually the case for systems attaching to an Internet Service Provider (ISP) and that want to establish VPN connections to their home gateway, the home gateway can use deferred selectors **22** to associate an unresolved identifier (ID), that is an ID that does not have an IP address associated with it, with a CD **26**. The resolution occurs dynamically during connection negotiation.

In accordance with the preferred embodiment of the invention, an API is provided for allowing access to VPN policy objects in a VPN Policy database from a GUI-type operations navigator (herein referred to as GUI). The API treats each data object (see FIG. **1**) as a separate database, where all databases together constitute a VPN Policy database. In this way, the API allows VPN policy objects to be created, deleted, and retrieved.

Each object in a database has a unique key for keyed reference. This key is either a name or an ID, depending or the database. An ID is an identification of a system or group of systems in the VPN (e.g. An FQDN or an IPV4 subnet). All references between objects of different databases is via object name.

All databases in which objects have names support keyed references by object name. All other databases support keyed references by ID (i.e., ID of a specific system or group of systems).

Some databases have their objects customer-ordered and therefore also support referencing objects by the ID(s) associated with objects of that database (a pair of client identifiers (client ID pair) in the case of connection definitions, and a single ID in the case of remote ID groups), on a first applicable object basis. Client ID pairs define a subset of IP traffic and are made up of the ID of a local system (or group of systems), a local port, the ID of a remote system (or group of systems), a remote port, and a transport protocol (e.g. TCP). Client ID pairs are sometimes referred to as Data Endpoints (in contrast to connection endpoints). When referencing customer-ordered objects in this way, the objects are checked in order by the API. The first object that is associated with a superset of the input IDs is returned.

In accordance with the preferred embodiment of the model, the following databases are provided: deferred selectors **22** database, including name field **81** that is used in a single system-wide Deferred Selector List; connection definitions database **26**, including name **82**, selectors **83** (copied from associated anchor filter **20**), local endpoint role **84** (gateway or host), remote endpoint role **85** (gateway or host), connection granularity **86**, initializer **87** (local, external, both), keying **88** (static or dynamic), lifetime **89**, NAT local client **91** (server hiding:boolean), and NAT remote client **92** (:boolean) fields, and any other information common to any connection protecting any portion of IP traffic specified by the selectors; remote endpoint ID groups database **32**, including a name **96**, and a list of IDs **108**; local endpoint IDs **34**, including a name and an ID; key management security policies database **36**, including name **97**, ISAKMP situation, initializer mode **98** (main/aggressive) and responder mode **99** (main/aggressive/*) fields; NAT address pools database **38**, including a name and a list of IP addresses **100**; key management proposals database **42**, including name field **102**; key management transforms database **44**, including authentication mechanism **103**, hash algorithm **104**, encryption algorithm **105**, pseudo-random function, lifetime, lifesize, key length, and DH group **106** fields; static authentication header security association (SA) pairs database **46**, including name, inbound and outbound IPSec security policy indices (SPIs), authentication algorithm, encapsulation mode (tunnel/transport), and key rounds; static encapsulating security payload (ESP) security association pairs database **48**, including name, inbound and outbound IPSec security policy indices (SPIs), encryption algorithm, authentication algorithm, encapsulation mode (tunnel/transport), and key rounds; static SA keys database **50**, including name and key; user client pairs database **52**, including name **110**, local client ID **111**, remote client ID **112**, remote endpoint ID **113**, initialization **114** (autostart, on-demand, user), and NAT local client (:boolean) **115** fields; IP addresses database **54**, including an input ID and an output IP address; key management preshared keys database **56**, including an input ID and a key; data management security policies database **58**, including name **120**, ISAKMP situation **121**, perfect forward secrecy **122** (:boolean), and SA refresh threshold **123** fields; data management proposal lists databases **60** and **62**, including name fields **124** and **125**, respectively; data management proposals database **64**, including name **126**, transform list **128**, ESP transform list **129**, and IPComp transform list **130**; data management transforms database **66**, including name **131**, type (ESP/AH/IPComp), encapsulation mode (tunnel/transport), encryption algorithm **132**, authentication algorithm **133**, DH group **134**, key length, key rounds, lifetime **135** and lifesize **136** fields, and IPComp info; and server addresses database, including external ID and a list of IP.

These databases are also referred to as objects, objects being the more general term.

Connections definitions database 26 holds connection definitions. A connection definition holds information on what a connection looks like and how it is made. It is used to map a subset of IP traffic to a security policy and certain connection attributes. Since a connection definition 26 maps directly to an anchor filter rule 20, a customer-defined order between connection definitions 26 exists in the database. Therefore, a connection definition 26 that is enabled to create connections externally (i.e., as an ISAKMP responder), can be referenced via a client ID pair (IDci/IDcr from an ISAKMP initiator) using the 'get first applicable' function of the API in addition to the object name 82. Connection definition 26 objects are unique with respect to its anchor filter rule 20. If an anchor filter rule 20 is loaded on multiple interfaces, then that connection definition 26 applies to those multiple interfaces. Since no runtime or operational information is kept in the VPN policy database, a single, uniquely named connection definition 26 may exist in the database and apply for all effected interfaces. When the effective remote client ID, IDci, is a non-IP type (e.g. User@FQDN), the connection definition 26 is selected by the 'get first applicable' function of the API, which uses connection definition's 26 deferred selectors 22 to reference a remote ID group 32 as a list of potential matches of the effective, non-IP type remote client IDs.

A user client pair object 52 is associated with a connection definition 26 and is used to describe actual connections to be initiated by this system, as distinguished from those connections initiated by external systems. Names 110 for user client pair objects 52 are not customer generated, but rather internally generated by the GUI by concatenating the object's connection definition 26 name 82 with a unique sequence number for that connection definition 26; separated by ':L' (ConnDefName:Lseqnumber). The 'L' indicates that the connection is defined Locally, as opposed to connections defined Remotely (ConnDefName:Rseqnumber). The GUI/customer learns these names via the 'List' or 'List Key' function of the API.

A user client pair object 52 may also contain references to static security association (SA) objects 46 and 48. This is the case when the user client pair 52's connection definition 26 indicates a static policy (i.e. no dynamic keying via IKE).

Deferred selectors 22 use unresolved IDs, such as user IDs, to point to a connection definition 26. This way, policy can be established to map multiple groups of IDs to different security policies 58 prior to knowing the IP address of any of the IDs.

All deferred selector objects 22 are referenced by a single system-wide deferred selector list 24. This list 24 is, in turn, referenced by a single anchor filter rule 20 (the mobile/Dynamic_IP users filter rule 20).

Remote ID group 32 is a customer-generated (via the GUI) list of IDs 108 (or single ID 108) associated with a group name 96. It also directly references the local ID 34, key management security policy 36, and NAT pool 38 objects for this group 108 of IDs. This is the database that IKE starts with to locate key management (phase I) security policy 36, given a remote ID (IDii, if responding or IDir, if initiating). Since a single ID may map to multiple remote ID group objects 32, a customer-defined order between remote ID groups 32 exist in the database. Therefore, a remote ID group 32 can be referenced on the 'get first applicable' function of the API based on identifier (ID).

Local IDs database 34 associates a local ID (IDii when initiating, IDir when responding) with a local ID name.

IP addresses database 54 maps an ID (for example, DER ASN1 distinguished name) to an IP address, as input by the user via the GUI. No verification is made via DNS or similar that this mapping is correct. This mapping may be used by IKE for authentication of key management security policy 36.

A security policy object 58 maps a connection definition 26 to objects used to define the type of protection for traffic with respect to that connection definition. It holds references 61, 63 to data management (phase II) negotiation information (that is, data management proposal list 64) for dynamic policies.

Data management (as opposed to key management) proposal list 60, 62 holds a list of data management proposals 64 in order of customer preference to offer in ISAKMP initiator 18 role or to match against in ISAKMP responder 19 mode.

Data management proposal 64 holds references for IKE 16, 17 to data management transforms 66.

Data management transform 66 holds information for IKE 16, 17 on a specific ISAKMP phase II transform to offer or match against. Phase II is an ISAKMP term for the negotiation of keys to protect the actual user data (i.e. the real VPN connection). This is in contrast to Phase I, which is the negotiation of keys for a ISAKMP/ISAKMP connection to protect Phase II negotiations. One aspect of the preferred embodiment of the invention is that VPN connections (the results of a Phase II negotiation) are based mainly on data endpoints, while key management connections (the results of Phase I negotiations) are based on connection endpoints.

Key management security policy 36 is used to describe ISAKMP Phase I connections via references 45, 47 to an initiator key management proposal 42 to offer in ISAKMP initiator 18 mode and to a responder key management proposal 40 to match against in ISAKMP responder 19 mode.

A key management proposals 40, 42 hold references for IKE 16, 17 to key management transforms 44 in order of user preference.

Key management transforms 44 hold information for IKE 16, 17 on a specific Phase I transform to offer or against which to match. Pseudo-random function (prf) is an attribute that is negotiated by IKE.

Key management preshared keys database 56 maps a system ID or user ID to a preshared key for the purpose of authenticating an ISAKMP Phase I connection, when the key management security policy 36 authentication mechanism 103 indicates authentication via pre-shared keys. This database 56 should be implemented with some sort of out of band encryption protection to keep the keys secret on the system.

A static security pair 46, 48 (one inbound, and one outbound) is used when a given connection definition 26 indicates connections to not use IKE for key management and instead use static IPSec information and keys 50. Static security association pair objects 46, 48 come in two types, each with their own database: static AH SA pairs 46 and static ESP SA pairs 48. Information in a static security association pair 46, 48 is similar to that of an IPSec security association pair. A security association pair (SA Pair) is an IPSec term (RFC2401) for information used in the kernal on how protect a selected datagram (e.g. What algorithm to use, what is the key, etc.) created by an ISAKMP Phase II negotiation.

Static security association key 50 maps a reference from a static security association pair 46, 48 to the keying material

50 to use for a static connection. This database 50 should be implemented with some sort of out of band encryption protection to keep the keys secret on the system.

NAT address pool database 38 lists all the external IP addresses 100 that can be used to NAT to/from a particular remote ID. Addresses from these pools 38 are used to NAT the local data endpoint address when a user client pair 52 indicates NAT local client 115 and to NAT the remote data endpoint address when a connection definition 26 indicates NAT remote client 92. This is described in detail in copending patent application Ser. No. 09/240,720.

Server is a database 28 that is used to hide the actual internal server address(es) 141 behind a single external, globally known server ID 28. This is done by NATing the local data endpoint address (not shown) to one of the server's internal addresses 141 whenever the connection definition 26 indicates NAT local client 91.

A series of 'integrity checks' or audits are performed on the data in the VPN Policy database to ensure correct operation of the VPN. These audits may be done either during policy creation and updating, or during runtime, when the data is acted upon. These audits include general audits and audits specific to a database. General audits include (a) ensuring objects referenced by other objects exist, (b) fields are valid, (c) object is unique with respect to its key (name or ID), and (d) indicated protocols and algorithms are supported.

Audits specific to a database include (a) no connection definition 26 can be updated or deleted while an active connection exists for that connection definition, (b) no proposal 64 is used that has an encapsulation mode 127 of transport when either of the used connection definition endpoint roles 84,85 indicates gateway, (c) if a connection definition 26 references a deferred selector 22, then the connection definition's granularity 86 for remote ID must indicate that the source of the connection's client IDs be from the client ID pair, and the remote endpoint role 85 must be host, (d) all connection definition selectors 83 must indicate IP-types (IPV4 or IPV6; address, subnet, or range), (e) user client pair's local client ID 111 and remote client ID 112 must be within the associated connection definition selectors 83, and must be correct with respect to the associated connection definition granularity 86, (f) if a connection definition's keying 88 indicates dynamic, a security policy reference 35 must exist, (g) is a. connection definition's keying 88 indicates static, all user client pairs 52 associated with the connection definition 26 must have a static AH SA pair reference 53 or a static ESP SA pair reference 55, or both, (h) no static AH SA pairs 46 or static ESP SA pairs 48 with an encapsulation mode of transport are referenced by a user client pair 52 that references a connection definition 26 with a local endpoint role 84 or remote endpoint role 85 of gateway, (i) no user client pair 52 can reference a connection definition 26 whose initializer 87 indicates external only, (j) length of key in static key 50 is correct for the algorithm it is used for, (k) ID type fields found in the VPN Policy database indicates ID types consistent with those of Table 1.

TABLE 1

	ID TYPES							
DB Object	IP Addr	IP Addr Range	IP Addr Subnet	ID Types User @ FQDN	ASN.1 DN	KEY_ID	I/F Name	Host Name (FQDN)
Conn Definition.Selectors	X	X	X				X	
User Client Pair.ClientIDs	X	X	X				X	X
UserClient Pair.Remote E/P ID (Dynamic	X			X	X	X		X
UserClient Pair.Remote E/P ID (Static	X							X
Deferred Selector.RIDG.RID				X	X	X		
RemoteIdGroup.Remote E/P ID	X	X	X	X	X	X		X
Server	X	X						
Local E/P ID	X			X	X	X		X
Internal Server ID	X	X	X					
NAT Pool ID	X	X	X					
IP Address.inId	X			X	X	X		
IP Address.outId	X							
Pre-shared Key.id	X			X	X	X		

In accordance with the preferred embodiment of the model, an API is defined for the purpose of creating, updating, deleting, and retrieving database objects in the VPN Policy database. Specific functions of the API include get_by_name (to retrieve objects from databases keyed by a name), get_by_id (to retrieve objects from databases keyed by an ID), get_first_applicable (to retrieve the first object that is associated with the input ID information; used for connection definitions 26 and remote endpoint ID groups 32), create, update, delete, list (to list all objects of a database in their entirety), and list_key (to list only the keys, i.e. Name or ID, of all objects of a database). The API is used by the GUI to create and update VPN security policy and by the IKE/VPN Mgr functions 16, 17 when creating and managing VPN connections.

A connection is a relationship between two IPSec endpoints 18, 19 that protect a specific set of IP traffic between them in a pre-defined manner, according to each endpoint's VPN policy.

Connections are created from connection definitions 26. Connection definitions 26 are user-specified objects that are associated one-to-one with a user-specified filter rule when that filter rule's action is 'Protect with IPSec'. This filter rule is called an anchor filter **20** rule. Anchor filter rules **20** are used to protect a subset of IP traffic according to a security policy **58**. Therefore, all connections created from a specific a specific connection definition will have the same security policy **58**. The exception to this is dynamically assigned IP addresses for remote, mobile users with dynamically-assigned IP addresses. For these cases, a single anchor filter rule **20** can be associated with multiple connection definitions **26**.

Because of this association of a single anchor filter rule **20** to a single connection definition **26**, and the fact that anchor filter rules **20** are ordered, connection definitions **26** have an inherent ordering among themselves. The IP traffic that is associated with a connection definition is specified by its selectors **83**, which are copied from its associated anchor filter rule **20** when the anchor filter rule is loaded onto the systems interface (i.e. becomes active). A set of selectors has the following attributes:

Local IP address (single,range,addr+mask,*)

Remote IP address (single,range,addr+mask,*)

Transport protocol (value,*)

Local port (value,*)

Remote port (value,*)

In order to create a connection from a connection definition **26**, a client ID pair is needed. A client ID pair is made of two client IDs, a local client ID and a remote client ID. Like selectors **83**, they are used to define a subset of IP traffic, for example all TCP traffic to or from host A from or to any host on subnet B. A client ID has the following attributes:

- ID type
  - IPv4 address
  - IPv6 address
  - FQDN (for example, foo.bar.com)
  - User FQDN (for example, piper@foo.bar.com)
  - IPv4 subnet (addr & mask)
  - IPv4 range (1st addr & last addr)
  - IPv6 subnet (addr & mask)
  - IPv6 range (1st addr & last addr)
  - DER ANS1 dist name
  - Physical interface or PPP profile name (implementation-specific)
  - 0 (meaning don't care)
- ID value
- Protocol (specific value, or 0 meaning don't care)
- Port (specific value, or 0 meaning don't care)

A client ID pair, in conjunction with a connection definition **26** (and it's related information such as security policy, etc.), provides all the information needed to create a connection. Thus,

connection definition +client ID pair =connection.

The client ID pair is obtained from a user-specified user client pair **52**, for the case of startable, scheduled on-demand, or autostart connections; or from a remote system via IKE, for responder-mode connections (i.e. IDci/IDcr). On-demand connections use data in the 'demanding' IP packet to define a client ID pair.

One or more connections can be created from a single connection definition **26**, depending on that connection definition's connection granularity **86**. Connection granularity **86** defines what subset of the IP traffic that is associated with this connection definition will be associated with each connection created from this connection definition **26**. It does this by specifying the source of the different attributes of a connection's local client ID and remote client ID. For each attribute, connection granularity **86** specifies the source as taken directly from the connection definitions selectors **83** ('filter'); a single value taken from the client ID pair ('single'); or taken directly from the client ID pair ('client').

By ensuring that all connections created from a connection definition **26** derive their local and remote client IDs in this consistent manner, and by ordering connections with more specific masked IP address (source address priority) ahead of those with less specific masked IP addresses, a predictable and non-conflicting ordering of connections can be derived when building the filter rules (SPD entries) for the IP stack. The exception to this is the last selection (that is, taken directly from client ID pair). This selection is used mostly for creating connections in responder-mode, since the connection granularity **86** of the Client ID pair of an initiating remote endpoint may not be known ahead of time. This, however, allows creation of connections that are not orderable in a predictable and non-conflicting manner. Therefore, this situation must be handled dynamically (that is, when loading the filter rules (SPD entry) for this connection to the kernel or, preferably, when IKE **16**, **17** is negotiating the Phase II Security Associations) to ensure that a candidate connection does not adversely overlap with an existing connection.

Referring to Table 2, local and remote endpoint roles are described.

TABLE 2

LOCAL AND REMOTE ENDPOINT ROLES

Local	Remote	Effect on Connection Granularity
Gateway	Gateway	No changes
Gateway	Host	Remote ID must be specific value
Host	Gateway	Local ID must be specific value
Host	Host	Local & Remote IDs must be specific values

Along with connection granularity **86**, another attribute of a connection definition **26** is local endpoint role **84** and remote endpoint role **85**. A role in this sense is either a security gateway (GW) or a host (H). The local endpoint is the system that will encrypt outbound traffic and decrypt inbound traffic. Conversely, the remote endpoint is the system that will decrypt and encrypt that traffic. The values of these two attributes **84**, **85** effect the allowable values for the connection definition connection granularity **86**. The values of these two attributes **84**, **85** also effect valid negotiable IP Sec transforms, in that if the local or remote role **84**, **85**, respectively, is gateway, no transform **66** may be negotiated that has an encapsulation mode of transport.

A connection's client IDs are generated using client ID pairs, local and remote endpoint roles **84**, **85**, connection granularity **86** and the connection definition's selectors **83**. This is done by:

1. Checking the connection definition selectors **83** for which granularity **86** indicates 'filter' against the local endpoint role **84** and remote endpoint role **85**, as shown in Table 2; and
2. Checking the client ID pair (either a user client pair **52** or an ISAKMP IDci/IDcr) to ensure it is within the bounds of the connection definition selectors **83**; and
3. Checking the client ID pair against the connection definition granularity **86** to ensure it is of the correct granularity (that is, granularity values of 'single' must correspond to single values in the client ID pair); and

4. Checking those attributes of the client ID pair for which the granularity **86** indicates 'single' or 'client' against the local endpoint role **84** and remote endpoint role **85**, as shown in Table 2; and
5. Using the client ID pair and the connection definition selectors **83** to generate the connection client IDs according to the connection granularity; 'client' or 'single' indicate the value comes from the client ID pair, 'filter' indicates the value comes from the connection definition selectors **83**.

The resulting connection client IDs are then used to create the filter rules (SPD entry) for this connection in the kernal.

Advantages over the Prior Art

It is a further advantage of the invention that there is provided a system and method for creating, maintaining, deleting and retrieving VPN policy objects.

It is a further advantage of the invention that there is provided a system and method for enabling acceptance of previously unknown IDci/IDcr values from a remote system.

It is a further advantage of the invention that there is provided a system and method enabling dynamic generation, load, and management of multiple IPSec filter rules.

It is a further advantage of the invention that there is provided a system and method enabling ISAKMP phase II driven phase I connections.

It is a further advantage of the invention that there is provided a system and method enabling handling of remote initiating hosts with dynamically assigned IP addresses with differing security policy requirements.

It is a further advantage of the invention that there is provided flexibility in policy definition in the areas of dynamically-assigned IP addresses, remotely-defined ISAKMP client IDs (IDci/IDcr), and separation of ISAKMP Phase I (key management) policy information from ISAKMP Phase II (data management) policy information.

It is a further advantage of the invention that there is provided a data model for representing and abstracting IPSec/ISAKMP-based VPN configuration information for an IPSec-capable computer system in a virtual private network that (1) allows for each customer-generated customer-ordered security policy database (SPD) entry, multiple VPN connections to be dynamically established (these connections may or may not have been previously defined); (2) allows for a data-security-policy-driven approach to rekeying (via IKE) where (a) the key management connection (i.e. the secure connection used to exchange keying material for the data connections) is created and maintained by security policy and on an on-demand basis by data connection activity, and (b) the key connection security policy is determined solely by the identity of the remote connection endpoint; (3) allows for dynamically establishing VPN connections with different security policies and other attributes, based solely on an unfixed IP address (e.g. a user ID)—these connections may or may not have been previously defined. This aspect is used for supporting systems with dynamically-assigned IP addresses that wish to establish a VPN connection with the local system.

Alternative Embodiments

It will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without departing from the spirit and scope of the invention. In particular, it is within the scope of the invention to provide a program storage or memory device such as a solid or fluid transmission medium, magnetic or optical wire, tape or disc, or the like, for storing signals readable by a machine for controlling the operation of a computer according to the method of the invention and/or to structure its components in accordance with the system of the invention.

Accordingly, the scope of protection of this invention is limited only by the following claims and their equivalents.

We claim:

1. A policy database system for managing security objects, comprising:

a deferred selectors component;

a connection definition;

a user client pair;

a manual connection component;

a remote connection endpoint attributes component including a phase I processing component; and

a phase II processing component;

said connection definition having a zero or one reference relationship with said deferred selectors component, a zero or more reference relationship with said user client pair, and a zero or one reference relationship with said phase II processing component; said user client pair further having a zero or one reference relationship with said manual connection component; and said deferred selectors component having a one and only one reference relationship with said remote connection attributes component.

2. The policy database system of claim **1** further for enabling acceptance at a responder node of a previously unknown client ID pair from an initiator node, said connection definition comprising indicia for determining if said unknown client pair is acceptable to said responder node and said phase II processing component comprising a policy for negotiating said unknown client ID pair.

3. The policy database system of claim **1** further for enabling dynamic generation, loading and management of multiple connection filters, said connection definition being selectable selectively by said user client pair or a client ID pair received from a remote initiator node for identifying pertinent granularity attributes defining the subset of datagrams that can be associated with any one connection instantiated from said connection definition.

4. The policy database system of claim **1** further for enabling ISAKMP phase II driven phase I connections, said remote connection endpoints attributes further comprising a remote endpoint identifier and a reference pointer for associating said remote endpoint identifier with a phase I negotiation policy in said phase I processing component.

5. The policy database system of claim **1** further for enabling secure connection by a responder node to a remote initiating host with dynamically assigned IP address, further comprising:

an anchor filter for defining datagrams that may be associated with remote hosts using dynamically assigned IP addresses;

said deferred selectors component further providing a one to many mapping from said anchor filter to said connection definitions.

6. A method for managing a policy database, said database including a deferred selectors component, a connection definition, a user client pair, a manual connection component, a remote connection endpoint attributes component including a phase I processing component; and a phase II processing component, comprising the steps of:

maintaining a zero or one reference relationship of said connection definition with said deferred selectors component;

maintaining a zero or more reference relationship of said connection definition with said user client pair;

maintaining a zero or one reference relationship of said connection definition with said phase II processing component;

maintaining a zero or one reference relationship of said user client pair with said manual connection component; and

maintaining a one and only one reference relationship of said deferred selectors component with said remote connection attributes component.

7. The method of claim 6, further for enabling acceptance at a responder node of a previously unknown client ID pair from an initiator node, comprising the further steps of:

determining from connection definition indicia if said unknown client pair is acceptable to said responder node, and if so

obtaining from said phase II processing component a policy for negotiating said unknown client ID pair.

8. The method of claim 6, further for enabling dynamic generation, load and management of multiple connection filters, comprising the further steps of:

obtaining from a said connection definition, selectively selected by said user client pair or a client ID pair received from a remote initiator node, granularity attributes defining the subset of datagrams that can be associated with any one connection instantiated from said connection definition.

9. The method of claim 6, further for enabling ISAKMP phase II driven phase I connections, comprising the further steps of:

associating a remote endpoint identifier in said remote connection endpoints attributes with a phase I negotiation policy in said phase I processing component.

10. The method of claim 6, further for enabling secure connection by a responder node to a remote initiating host with dynamically assigned IP address, further comprising the steps of:

providing an anchor filter for defining datagrams that may be associated with remote hosts using dynamically assigned IP addresses; and

said deferred selectors component further providing a one to many mapping from said anchor filter to said connection definitions.

11. A program storage device readable by a machine, tangibly embodying a program of instructions executable by a machine to perform method steps for managing a policy database, said database including a deferred selectors component, a connection definition, a user client pair, a manual connection component, a remote connection endpoint attributes component including a phase I processing component; and a phase II processing component, said method steps comprising:

maintaining a zero or one reference relationship of said connection definition with said deferred selectors component;

maintaining a zero or more reference relationship of said connection definition with said user client pair;

maintaining a zero or one reference relationship of said connection definition with said phase II processing component;

maintaining a zero or one reference relationship of said user client pair with said manual connection component; and

maintaining a one and only one reference relationship of said deferred selectors component with said remote connection attributes component.

12. An article of manufacture comprising:

a computer useable medium having computer readable program code means embodied therein for managing a policy database, said database including a deferred selectors component, a connection definition, a user client pair, a manual connection component, a remote connection endpoint attributes component including a phase I processing component; and a phase II processing component, the computer readable program means in said article of manufacture comprising:

computer readable program code means for causing a computer to effect maintaining a zero or one reference relationship of said connection definition with said deferred selectors component;

computer readable program code means for causing a computer to effect maintaining a zero or more reference relationship of said connection definition with said user client pair;

computer readable program code means for causing a computer to effect maintaining a zero or one reference relationship of said connection definition with said phase II processing component;

computer readable program code means for causing a computer to effect maintaining a zero or one reference relationship of said user client pair with said manual connection component; and

computer readable program code means for causing a computer to effect maintaining a one and only one reference relationship of said deferred selectors component with said remote connection attributes component.

13. A policy database system for managing security objects and enabling ISAKMP phase II driven phase I connections, comprising:

a deferred selectors component;

a connection definition;

a user client pair;

a manual connection component;

a remote connection endpoint attributes component including a phase I processing component; and

a phase II processing component;

said connection definition having a zero or one reference relationship with said deferred selectors component, a zero or more reference relationship with said user client pair, and a zero or one reference relationship with said phase II processing component; said user client pair further having a zero or one reference relationship with said manual connection component; and said deferred selectors component having a one and only one reference relationship with said remote connection attributes component; and

said remote connection endpoints attributes further comprising a remote endpoint identifier and a reference pointer for associating said remote endpoint identifier with a phase I negotiation policy in said phase I processing component.

14. A method for managing a policy database and enabling ISAKMP phase II driven phase I connections, said database including a deferred selectors component, a connection definition, a user client pair, a manual connection component, a remote connection endpoint attributes component including a phase I processing component; and a phase II processing component, comprising the steps of:

maintaining a zero or one reference relationship of said connection definition with said deferred selectors component;

maintaining a zero or more reference relationship of said connection definition with said user client pair;

maintaining a zero or one reference relationship of said connection definition with said phase II processing component;

maintaining a zero or one reference relationship of said user client pair with said manual connection component;

maintaining a one and only one reference relationship of said deferred selectors component with said remote connection attributes component; and

associating a remote endpoint identifier in said remote connection endpoints attributes with a phase I negotiation policy in said phase I processing component.

15. A program storage device readable by a machine, tangibly embodying a program of instructions executable by a machine to perform method steps for managing a policy database and enabling ISAKMP phase II driven phase I connections, said database including a deferred selectors component, a connection definition, a user client pair, a manual connection component, a remote connection endpoint attributes component including a phase I processing component; and a phase II processing component, said method steps comprising:

maintaining a zero or one reference relationship of said connection definition with said deferred selectors component;

maintaining a zero or more reference relationship of said connection definition with said user client pair;

maintaining a zero or one reference relationship of said connection definition with said phase II processing component;

maintaining a zero or one reference relationship of said user client pair with said manual connection component;

maintaining a one and only one reference relationship of said deferred selectors component with said remote connection attributes component; and

associating a remote endpoint identifier in said remote connection endpoints attributes with a phase I negotiation policy in said phase I processing component.

* * * * *